tory by the name of *alumine* or *alumina*, a name derived from *alum*, a well known substance that crystallizes in regular octohedra, and is a compound of *sulphuric acid, potash*, and *alumina*.

The curious fact of alumina being identical with that which confers plasticity upon clay, was known in the infancy of chemical science; it was called an earth, an argillaceous, non-alkaline earth, and resisted all attempts at decomposition or resolution into any other forms of matter. Barron entertained an opinion that alumina was of a *metallic* nature, and Lavoisier had sufficient penetration to state that it was a *metallic oxide* whose elements were held in union by an affinity too powerful for any known agent to overcome. Notwithstanding these surmises as to its nature, alumina was experimentally acknowledged to be a simple or elementary substance until the year 1808. Soon after Davy had decomposed the fixed alkalies, potash and soda, and proved them to be oxides of the metals potassium and sodium, and found that the power of potassium, or its affinity for oxygen, was superior to all other substances, he was induced to apply it to alumina, reasoning as follows:—If alumina be a compound in which oxygen exists, it is probable that the intense affinity of potassium for such element, will deprive alumina of it, and so elicit the *base*, be it what it may, of alumina. An appeal to experiment established the fact of alumina being a compound of oxygen and a peculiar substance apparently *metallic*, for which Davy proposed the name of *aluminum*, but he scarcely examined its properties on account of the extremely minute portions that he could obtain by his analysis. Many chemists refused to admit this view of the compound nature of alumina—refused, that is, to rank it with other metallic oxides; but all are now agreed about the matter, since Wohler's accurate analysis in 1828, when he succeeded in procuring the metal *aluminum* in tangible quantity, and found that upon causing it to exert affinity for oxygen, the sole product or compound was *alumina*. Thus from the evidence of analysis and synthesis, alumina is proved to be an oxide of the metal aluminum, and the original notions of Barron and Lavoisier are corroborated by actual experiment.

In the science of chemistry, the term *alumina* is of more convenient employment than that of *protoxide of aluminum*, which is the strict ultimate term, and it is likewise usual to denote all the oxides formerly called alkalies and earths except lime by the termination *a*; on the other hand, all metals of modern discovery are distinguished by the termination *um*; *vide* the list of elements.

The chemical properties of aluminum are of no practical utility in construction, but those of alumina are of the greatest possible interest and importance.

By the action of ammonia upon a solution of alum, the sulphuric acid, and the potassa of that salt are removed or withdrawn, whilst its pure alumina precipitates in the form of a perfectly white substance, and this when collected and dried at common temperatures retains about half its weight of water, it is therefore a hydrate of alumina. This will readily mix with more water, and form a plastic mass, but no solution of alumina takes place, and for all practical purposes it may be regarded as absolutely insoluble in water.

Some kinds of fine white clay, although containing an enormous per centage of alumina, are not chemically pure, and these, when breathed upon or wetted with water, emit a peculiar odour, like that of moist "Fuller's earth," or some varieties of stone employed for pavements; this odour is known by the name of *argillaceous*, and was supposed to be peculiar to pure alumina; recent researches prove, that pure alumina thus treated has no odour, but if a very minute portion of oxide of iron be present (as it always is in the very purest native specimens of clay), that the odour is immediately evolved, when breathed upon or moistened with water.

Artificially, pure alumina, and all natural specimens of clay containing it, retains water with great and persistent affinity. This can only be expelled at a bright red heat, and leaves the alumina *anhydrous*, but no longer plastic or miscible with water. In this anhydrous state the substance is excessively hard, therefore its fine powder is occasionally advantageously employed for grinding and polishing metal work. This affords a striking example of the physical or mechanical character of a substance being wholly altered by the abstraction of water.

Alumina is perfectly infusible, and hence its extreme value as a material for the manufacture of crucibles, and other vessels that are intended to withstand intense heat.

"Cornish clay" and "pipe-clay" each contain a very large per centage of pure alumina, and, accordingly, they are extremely refractory in the fire, but the presence of sand and lime renders them fusible. Many "clays" naturally contain the two last-named substances, and are, therefore, perfectly unfit for the manufacture of bricks.

All "clays" contain more or less of the oxide of iron; and to this substance their various shades of colour is chiefly referrible; and when a light yellow clay is heated red-hot, or, technically speaking, "burned," it assumes a bright red colour, on account of the iron assuming its highest degree of oxidation, or, in other words, becoming *peroxide* of iron.

"Burnt clay," being anhydrous, hard, and insoluble in water, forms an excellent material for the foundation of roads, &c., and is now most abundantly used in many operations of building and of civil engineering.

By selecting a white clay, and artificially blending it with various metallic oxides, the potter is enabled to produce all the well-known varieties of coloured pottery, paving tiles, &c.; thus a red colour is conferred by the peroxide of iron, blue, by the oxide of cobalt, green, by the oxide of chromium, black, by the oxide of manganesium, and various intermediate tints by the judicious intermixture of these and other metallic oxides in certain proportions. The heat of the kiln in which articles of pottery are "baked," causes intense chemical affinity to ensue between the alumina and the colouring oxides, so that the tints, or stains, are perfectly indelible by the most protracted exposure to all vicissitudes of the weather.

The quality of bricks materially depends upon the judicious "tempering" of the clay with water, and the subsequent "burning," to expel the water. This matter appears extremely simple, but in fact it demands much practical skill.

For example, if the "brick earth" contain a very large proportion of real clay, the bricks made of it will shrink and crack in the mere drying by exposure to the air; and if it contain a large quantity of sand, then the bricks will be heavy and brittle.

"Tempering" the very same clay in two different ways, will even produce a decided difference in the quality of bricks, as the following account of an experiment will shew in a remarkable manner.

A sample of clay was heavily beaten for half an hour, then divided into two parts; one part was beaten for three-quarters of an hour longer; a brick was made of each portion with the same pressure, in the same mould, then dried and burned under the same circumstances; these bricks were tested as to strength by placing them on a sharp edge, and gradually loading each of their ends with weights; the result was, that the brick made of the clay beaten for half an hour, broke with thirty-five pounds at each end, or *seventy pounds* on the whole; whilst the other did not break until the addition of sixty-five pounds at each end, or *one hundred and thirty pounds* upon the whole.

The strength depended upon the materials of the clay being closely and accurately brought into contact by the mechanical force of the blows used in the "tempering," and thus enabled by the after-process of "burning" to exert chemical affinity for each other in a more powerful and perfect manner than, in their comparatively porous state, of the shorter tempering.

For making good sound bricks, the clay should be dug some years before it is wanted, that it may have time to "mellow," or in other words for the alumina, the silica, and the oxide of iron to act well upon each other by the intervention of the air, then good "tempering," and judicious "burning."

Alumina occurs as an essential constituent of several building materials, as, for instance, in all kinds of slate and granite—the latter consisting of three distinct substances, viz. *quartz, mica*, and *felspar*. The first of these is pure silica, the second is a compound of magnesia, and the third, or *felspar*, a compound containing a large amount of alumina.

When the *felspar* predominates, especially in the form of large white crystals, the granite is extremely prone to crumble and decay, and is perfectly unfit for the uses of the architect. Some of the Cornish granite is so remarkable for its spontaneous disintegration, that the variety of white clay called "Cornish clay" (so highly prized for the manufacture of porcelain), entirely results from the decomposition of the felspar.

In these papers on "Chemistry as applied to Construction," frequent mention has been made of *silica*; it is presented by nature extremely pure in the substance popularly known as "crystal," or "rock-crystal," the form of which is a six-sided prism, having a six-sided summit; and from its being perfectly colourless and transparent, the ancients deemed it to be water, congealed into a more solid state than that of ice, and therefore incapable of thawing.

Modern chemistry proves "crystal" to be anhydrous, and to consist of the same substance as flint or *silex*, hence the derivation of the term *silica*. Some of its characters are now to be mentioned.

All varieties of the substance called *quartz*, contain silica in various states of purity, and the fine white sand obtained either from Lynn, on the coast of Norfolk, or from Alum Bay, in the Isle of Wight, present silica nearly as pure as "crystal." Silica is characterized by extreme hardness, insolubility in water under ordinary circumstances, infusibility in common furnace heat, and until the year 1808 chemists regarded it as a *simple earth*.

Sir Humphry Davy experimented upon silica by means of the metal potassium, and made the important discovery of its *compound* nature, proving it to consist of the element *oxygen*, and a peculiar new inflammable substance, which he named *silicon*; other chemists have modified this term into *silicium*, regarding it as a metal, and as such it is ranked in the list of elements already given.

Silicon or *silicium* is a dark brown powder, infusible, and inflammable, producing *silica* by uniting with oxygen, so that the pure matter of crystal, quartz, flint, and sand, may be called *oxide of silicium*; but this substance under certain conditions has the power of uniting with metallic oxides, after the manner of an acid, and is frequently called *silicic acid*, and the compounds that it forms with such oxides are called *silicates*.

The general chemical characters of *silicon* or *silicium* require more perfect investigation before it can be assigned its proper station amongst the elements. It may belong to the class of non-metallic elements; it may belong to the class of metallic elements; and as experiment proves that the *bases* of all the other substances so long regarded as *earths* are most decided *metals*, analogy strongly justifies the opinion that the substance in question is also a *metal*; it is of no practical importance, but its native combination with oxygen, viz. *silica*, is of the highest value to the architect, engineer, operative, and artist.

The chemical affinity of finely divided silica (sand) for alumina is so great, that the two substances combine to a certain extent, when presented to each other in a moist state, as in the preparation of "brick earth" and "porcelain clay;" hence the advantage of keeping these materials for a very considerable time before use, that the combination may take place and be ultimately perfected by the process of "tempering." The duly tempered clay may then be regarded as *hydrated silicate of alumina*, and the operation of "burning" drives off the water, leaving the *silicate* anhydrous, hard, and of extreme durability. Brick or pottery, when composed of absolutely pure alumina and silica, may be considered as *anhydrous silicate of alumina*; if oxide of iron be present, as it is in common clay, then the result is *anhydrous alumino-silicate of iron*.

Although silica is infusible alone, if it be mixed with potassa, or soda, and heated intensely, it exerts chemical affinity for these metallic oxides, combines with them to form a perfect fluid, which, when cooled, constitutes the invaluable material known as *glass*. In order to understand its chemical nature, some of the properties of potassa and soda require description.

These substances were formerly called "the